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The use of visual aids in the teaching of junior high school mathematics

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THE USE OF VISUAL AIDS IN THE TEACHING OF JUNIOR HIGH SCHOOL MATHEMATICS

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CHAPTER I

INTRODUCTION

The Problem

Functional trends in junior high school mathematics.--Mathematics teachers are setting up for themselves aims and objectives which they hope to obtain in the classroom. It is the writer's belief that to obtain these objectives the work presented must be meaningful and practical from the pupil's point of view. The material to be learned must touch his life in very real and vital situations. He must see a need and a use for the thing he is spending time to learn.

Dr. Roy O. Billett says:[1]

> .... One can sense the increasing emphasis on functionality and integration of mathematics courses at the junior-high-school level in the topics now commonly recommended for such courses in treatises on the teaching of secondary school mathematics. Almost invariably the following topics appear: money, banking, investments, insurance, taxes, household accounts, simple graphs, intuitive geometry, the formula, the simple equation, directed numbers, direct and indirect measurement.

1/Roy O. Billett, Fundamentals of Secondary-School Teaching, Houghton Mifflin Company, Boston, 1940, pp. 300-301.

Ernst R. Breslich says:[1]

....Analysis of text books[2] shows a close agreement as to the major purposes of the arithmetic of the junior high school. Briefly they are: to enable pupils to deal successfully with such quantitative situations as they are likely to meet in their every day experiences, particularly in their school studies; to prepare them, as far as it seems feasible, to meet quantitative situations in adult life; to give them an understanding of the meanings of the social uses and applications of arithmetic; and to develop a high degree of familiarity with, and accuracy in, the fundamental processes of arithmetic.

William A. Brownell, of Duke University, says:[3]

Teachers can best insure that mathematics will be permanently useful by making it useful during the learning. The writer does not for a moment advocate that mathematics be taught exclusively or mainly in an incidental way or in a program of activity units in which the mathematics too often is hidden and unidentified. He is suggesting that arithmetic and other forms of mathematics should be employed outside the mathematics period, and outside the school, and should be employed in connection with problems which are real to children. Arithmetic serves vital needs when it is used with keeping scores; in running the school store; in figuring comparative standings of class teams in an athletic or a literary league; in making budgets, in estimating expenses, in checking purchases, and so forth. Geometry serves vital needs when it is used in laying off a baseball or football field or a badminton or tennis court. Mathematics must escape the confines of the text books, the class period, and the school.

1/Ernst R. Breslich, Problems in Teaching Secondary-School Mathematics, University of Chicago Press, Chicago, 1940, p. 11.

2/Mabelle Dorothy Dhus, "A Determination of the Tendency of Junior High Mathematics," Master's thesis, University of Chicago, 1927, p. 78.

3/William A. Brownell, "Essential Mathematics for Minimum Army Needs," School Review (October, 1944), 52:484-492.

These are only three of many educators who have written about the functional trend in junior-high-school mathematics and urged the teacher to correlate her work with other interests common to the pupils in her class. The writer believes that through the use of visual aids in the schoolroom the present mathematics courses may be enriched and made more meaningful to the pupil.

Use of visual aids in making mathematics meaningful to the pupil.-- According to McKown and Roberts, a visual aid is a device used to present a clearer concept, appreciation or interpretation of the material to be learned.[1] It is not sufficient unto itself but is used to supplement the instruction given. These authors also tell how visual aids have entered the classroom in many fields of study and often contributed a great deal to the development of concepts presented.[2] The writer has not been overburdened with information about visual aids in the field of mathematics but it is her belief that there are great possibilities in the use of them to make mathematics a real and vital part of our pupils' thinking. Because of this she will endeavor to present in this paper suggestions of specific ways in which a teacher may use visual aids to supplement her present methods of teaching in the hope

1/Harry C. McKown and Alvin B. Roberts, Audio-Visual Aids and Instruction, McGraw-Hill Book Company, Inc., New York, 1940, p. 6.

2/Ibid., pp. 243-324.

that through them the pupil may gain an appreciation of the importance of mathematics to his everyday living and a clearer and more inclusive understanding of the material presented.

With these aids the teacher may introduce life situations calling for knowledge of the classroom arithmetic; she may encourage hobbies and other leisure-time activities that will enrich the lives of her pupils; she may better fit them to take their place in the world because she has given to them a working, useful course in mathematics.

Arithmetic will have real value for the boy or girl who collects coins or stamps, makes model airplanes or boats, makes puppets, knits, plans a victory garden, or starts a paper route. Many children will find pleasure in helping the family plan for the laying of linoleum or tiles, painting the house, or redecorating his own room if the methods of procedure tie in with his work at school. Extra research in social studies, English, shop, or art will be pursued if the pupil has been made to see how scale drawing will help him on maps, designs, or models of rooms or buildings, or how a graph gives information quickly and accurately for all to see at a glance. The writer has known young people who have persuaded their folks to let them be responsible for the purchasing of their clothing after the budget has been studied in school. In this project the mathematics and household-arts departments

can share a responsibility.

William A. Brownell recognizes the need for visual aids in teaching mathematical meanings and relationships. He writes:[1]

> ....If teachers took the vow to teach no arithmetical idea, process, or skill unless they could make it sensible to children, they would have to change drastically their class room practices. They would find that they have to teach arithmetic mathematically for the sense in arithmetic inheres in the mathematics of numbers and of the number processes. This statement does not mean that visual and other sensory aids would be discontinued. Quite the contrary; their use would be doubled or trebled, for through such aids many mathematical meanings and relationships are most readily represented.

Material to Be Presented

Types of material.-- Throughout this paper the following teaching aids will be considered: bulletin board material, lantern slides, stereographs, film strips, motion pictures, and museum material.[2] Bulletin board material will include all flat pictures such as photographs, clippings from magazines or newspapers, posters, charts, drawings, cartoons, and graphs. Stereographs, film strips, and motion pictures will be entirely commercial material unless the teacher is interested in photography.[3] The writer has seen a very fine

1/William A. Brownell, "Essential Mathematics for Minimum Army Needs," School Review (October, 1944), 52:487.

2/More detailed material about each will be found in the second chapter.

3/C. B. Neblette, Frederick W. Brehm, and Everett L. Priest, Elementary Photography for Club and Home Use, The Macmillan Company, Boston, 1942.

film produced by a teacher giving the early history of the town in which he taught. The pupils were the actors, and all the scenes were taken locally. Museum material will include loans from local museums and also models, specimens, and objects brought in to the classroom by the pupils. Lantern slides may be obtained through commercial concerns in a few instances, but most of them will be homemade slides that the pupil himself will plan and design. These have various uses in the classroom.[1/]

Procedure for finding this material.-- The writer has made a study of books, articles, and visual education catalogues to obtain information about material already on the market. This material will be described in a later chapter and information pertinent to obtaining it will be included. The writer believes that even more valuable than the commercial material is the material within the grasp of the pupil. This the pupil can bring from home, such as measuring devices, house plans, or insurance policies. Other aids he may make at school or at home as a leisure-time activity. Posters, graphs, and models are examples of things this group includes.

The writer has made a study of the objectives of six topics frequently included in junior-high-school mathematics and considered possibilities for the use of visual aids to supplement and improve the teaching program. With these

1/Described in Chapter II.

objectives in mind she has made a study of the uses that the previously mentioned teaching aids have to offer and under each topic has made some specific suggestions for their use.

CHAPTER II

TYPES OF VISUAL AIDS DISCUSSED IN THE PAPER

Purpose of Chapter II

Teacher preparation for the use of visual aids.-- It is the writer's belief that the value of visual aids in any classroom is greatly affected by the teacher's knowledge of how they may be used. Before attempting to use the aids described in this chapter the writer recommends a careful study of the reference pages indicated in the text. Although the following statement by Anna Verona Dorris may only be true in part today, its underlying principle still stands.[1/]

> ....Many schools throughout the country are well equipped with visual materials and apparatus, but they are used in a haphazard fashion and with little knowledge of any definite technique governing their employment. The finest tool is worthless if placed in unskilled hands. Its effective use depends upon the skill of the operator.

Description of material available.-- In this chapter the writer will describe seven types of teaching aids that she has found useful in the teaching of junior-high-school mathematics, and will include in each description specific examples of how they may be used.

1/Anna Verona Dorris, Visual Instruction in the Public Schools, Ginn and Company, Boston, 1928, pp. 370-371.

Opaque Projections

The use of the opaque projector.-- The opaque projector is perhaps the most useful single piece of apparatus a teacher may possess, for with it she can project pages of a book without harming the book in any way. The projector will reflect any flat pictures from bound volumes, magazines, or newspapers ranging in size from very small pictures to those of about eight inches in length or width. Flat objects such as pins in the shape of geometric designs, petals of a flower, dress goods, insurance policies, checks, or labels from a package of foodstuff may be shown. Children's papers may be placed under the machine to be evaluated by the class. An automatic fan acts as a cooling device to protect the material from the heat of the lamp. A special carrier for post cards may be purchased. Because the light must be reflected by mirrors within the machine the picture is not as bright as one through which the light can pass; therefore the room must be dark for clear projection.

Sources of material.-- Printed matter from magazines, newspapers, advertisements, pamphlets, posters, graphs, or drawings may be classified in the teacher's file and kept for future use. A card catalogue to list illustrations in bound volumes that cannot be cut will give the teacher a wealth of material from which to make selections for a specific lesson.

Ways machine may be used.-- The machine may be used to show descriptive material illustrating information given, such as a series of pictures illustrating the use of the circle in everyday living; for critical study, such as a graph or two demonstrating the rules for constructing a graph; for evaluation of papers, such as a group of class papers showing types of careless errors pupils make.

Lantern Slide Projection

Use of the lantern slide projector.-- The lantern slide projector is used for glass slides $3\frac{1}{4}$" x 4". Commercial slides may be purchased or rented for classroom use, but at present there are few obtainable in the field of junior-high-school mathematics. The homemade lantern slides are of more value to the teacher. Their average cost is only a little more than five cents per slide and this slide may be washed off and used again.

The making of lantern slides.-- Even young children find lantern slides easy to make. Because they have proved to be so valuable as a teaching aid to the writer, she is including a brief description of several types that are easy to do. The materials needed may be purchased from any visual aid supply company and from some school supply houses. All the materials needed are available from Keystone View Company.[1/]

1/Keystone View Company, Meadville, Pennsylvania.

There are a few general rules that may be applied to all the types mentioned below. All slides must be drawn with the glass held horizontally, and quarter-inch margins must be kept. Wax crayons will not keep their true colors and the heat from the lamp melts them. Mongol crayons may be used, but the best results are obtained from the lantern slide crayons and paints that Keystone puts out for this purpose. The slides may be washed off with any scouring soap and warm water. If the slides are worth keeping in a permanent collection a slide file should be started. Much that Manning Bleich[1] has to say about the method, procedure, and value of such a file for social studies is also true for mathematics.

Plain glass slides.-- Plain glass cut to the correct size, which is called cover glass commercially, may be purchased for about thirty cents a dozen. Pupils can draw on this cover glass with India ink. Although this is the cheapest type of homemade slide it is also the least effective for the lines are heavy and there is no chance to introduce color.

Ground glass slides.-- With a fifty-cent can of an abrasive, called glassive,[2] and a little water the pupil can etch the cover glass very easily by following the directions that come with the glassive. On this etched glass the pupil can

1/Manning Edward Bleich, "The Production of a Slide File for Social Studies Classroom," High Points (March, 1942), 24:40-45.

2/Obtainable from Teaching Aids Service, Jamaica Plain, Mass.

draw with a pencil and add color to his slide by the use of mongol crayons or Keystone crayons or paints. For a black outline India ink may be used.

Cellophane slides.-- On a piece of cellophane cut to the same size as the cover glass, known commercially as cello-slide, a pupil may draw with India ink and then bind the cellophane between two pieces of cover glass.

Typewritten slides may be made in a similar manner by folding a piece of carbon paper 4" x 6½" over the cellophane with the carbon next to the cellophane. By typing on the carbon the print is impressed on the cellophane which may be bound between two pieces of cover glass.

Silhouette slides.-- Designs or diagrams may be cut from paper and bound between two pieces of cover glass. Flat objects such as real leaves may also be treated in this manner.

Photographic lantern slides.-- A photographic lantern slide may be made from any negative with the use of a piece of glass prepared for the purpose.[1/] This sensitized glass may be purchased from an Eastman Kodak Company store.

Museum Material

The use of public museums.-- Public and private museums within easy access of the school can prove to be valuable

1/How to Make Good Pictures, Eastman Kodak Company, Rochester, New York, pp. 156-163.

teaching aids.[1] The alert teacher will know the location of these as well as the services they render. Many exhibits although not listed as being in the field of mathematics will add meaning and realism to the pupil's work in mathematics. The recent exhibit of miniature rooms at the Boston Museum of Fine Arts was an outstanding illustration of work done to scale. Excavations suggest problems in finding the area and volume of the ground worked, the cost of equipment, the determination of dates, and the problems of transportation.

Public museum loans.-- Many museums loan exhibits to schools.[2] Some have special classes or programs for boys and girls after school or on Saturdays.[3] The Children's Museum in Jamaica Plain publishes a bulletin every month describing activities of interest to the children. Many have slide films and flat pictures they will loan upon request. Some have libraries open to the public. Recently in The Business Education World[4] there appeared a list of museums maintaining regular departments for the purpose of offering these services to teachers.

1/Frederick Houghton, "Museums Are Educational Institutions," Journal of Education (January, 1945), 128:28.

2/Natural History Museum, Boston.

3/Children's Museum, Jamaica Plain, Mass.

4/E. Dana Gibson, "Audio Visual Business Education," The Business Education World (March, 1945), 25:369-370.

School museums.-- More valuable than the public museum is the school museum made by the pupils themselves.[1] An exhibit may be arranged for a given period of time and then the pieces returned to their owners or kept on a permanent loan basis for future classes. Every school should have a museum room where these gifts may be kept in good condition. A school museum exhibit might be built around a model of the stock exchange, with old stock certificates, ticker tape, and dividend notices on display. Whatever the child can bring in to an exhibit of this kind will add meaning and importance to his mathematics lesson.

Models.-- Because the making of models is a time-consuming activity requiring a certain amount of talent the writer usually assigns it as a leisure-time activity for those who are particularly interested in that type of work. Much incidental arithmetic in measuring, figuring out a scale, estimating the cost will be done before the model is ready for exhibition. Models of geometric figures, the stock exchange floor, measuring devices, and model homes are a few suggestions for this work.

1/Charles F. Hoban, Charles F. Hoban, Jr., and Samuel B. Zisman, Visualizing the Curriculum, The Dryden Press, Inc., New York, 1937, pp. 63-89.

Motion Pictures

Value of motion pictures in the schools.-- Charles F. Hoban's discussion of the effective use of motion pictures in the school as a means of improving general education is only one of many evidences of the trend to bring motion pictures into the classroom. He says:[1]

> In the writing of this report there are two basic purposes: first, to demonstrate that motion pictures do not merely do better what is being done by lectures and textbooks but do something entirely different, and that in this difference there exists the potentiality of a different kind of education for a better world and a better life; second, to summarize and interpret the best of what was learned in the Motion Picture Project so that producers and users of educational motion pictures may be assisted in converting this potentiality into actuality.

The use of motion pictures.-- The writer regrets to say that up to the present time she has been unable to use any motion pictures in her mathematics classes, but she is including them in this paper for the reader's consideration, because she feels that they have value in the mathematics program. It is very important that the films be used to further educational growth and not as a means of entertainment. The teacher should be acquainted with the content of the film. A list of questions presented before the picture is shown directs the pupil's thought and helps him to pick out the important points in the film. In order to obtain the best teaching results

1/Charles F. Hoban, Focus on Learning, American Council on Education, Washington, D. C., 1942, p. 151.

from a motion picture the teacher should make a careful study of how a film should be used.[1] Other valuable methods of procedure are discussed in Wood and Freeman's book, Motion Pictures in the Classroom.[2] A teacher should read it before attempting to present a lesson of this kind for the first time.

Bulletin-Board Material

Types and sources of material.-- Because the bulletin board has such a prominent place in the classroom the material to be placed upon it should be attractive and carefully chosen. Every teacher should have a picture file where she may store pictures, cartoons, charts, graphs, and diagrams varying from very expensive prints to newspaper or magazine clippings. Many advertisements contain good illustrative material for the mathematics class. One of the most impressive examples of symmetry the writer has seen came from the comic strip on "Cicero's Cat." Pictures that are too small for room display may be used in the opaque projector.

If the mathematics teacher will keep himself informed about the pupils' work in other classes he can use illustrative material that will tie in with the other subjects

1/Charles F. Hoban, Charles F. Hoban, Jr., and Samuel B. Zisman, Visualizing the Curriculum, pp. 63-89.

2/Benjamin D. Wood and Frank N. Freeman, Motion Pictures in the Classroom, Houghton Mifflin Company, Boston, 1929.

studied. An exhibit of pictures showing modes of travel and the relative costs of each might tie in with a social studies lesson on the growth of the West.

Pictures that suggest junior-high-school-age hobbies and interests will have more appeal and therefore more teaching value than illustrations picked at random because of a mathematical principle depicted. Scale drawing can be illustrated with plans of model airplanes, boats, and gliders, or with enlarged drawings of parts of flowers or insects that the children may be studying in science.

Pupil participation in planning the bulletin board.-- Some members of the class will take a special interest in arranging the bulletin board. These people may be organized into a committee for this purpose, changing the display frequently and urging other pupils to contribute material.

The Book Shelf

The use of the book shelf.-- In thinking of the mathematics class as a place for drill and problem solving, we often miss a splendid opportunity to stimulate interest in mathematics by not providing supplemental reading material. At all times there should be a mathematics book shelf for those people who have the time and interest to make use of it.

Ernst R. Breslich says:[1]

> Every classroom should have at least one book shelf with different textbooks containing readings parallel to the topics discussed in class....Moreover to provide for the various interests which pupils develop there is need for books on mathematical recreations, for histories of mathematics, for copies of mathematical journals, and for mathematical tables. There is a demand for reading materials and supplementary exercises needed for those who wish to do more than the required work. In a certain sense, the extent to which pupils become really interested in the subject is a measure of the teacher's success ....When they voluntarily undertake an independent piece of work, they are in need of ample reading material.

The purpose of the book shelf.-- The writer feels that the book shelf should be fourfold in its purpose. Primarily it should provide supplementary reading on the topics studied in class. It should also provide extra drill work for the pupils who need it. The writer always keeps three or four textbooks, similar to the one used as a basic text, on the shelf. These books have the answers included so that a pupil may find parallel work to that done in class and check his progress by trying similar problems. The books provided should help the pupil to extend the classroom work into his leisure-time activities. Mildred Ryan's book Your Clothes and Personality[2] would work in with a study of the budget and help the girl who is interested in making dress designs or in

1/Ernst R. Breslich, The Technique of Teaching Secondary School Mathematics, University of Chicago Press, Chicago, 1930, p. 130.

2/Mildred Graves Ryan, Your Clothes and Personality, D. Appleton-Century Company, New York, 1941.

sewing for herself. Home Handicraft for Boys[1] and a similar book for girls[2] teaches a great deal about scale drawing, although its main purpose is to help boys and girls to make things they like. The fourth purpose of the book shelf is to correlate the pupil's work in mathematics with his other school work. The book Man at Work: His Arts and Crafts[3] suggests the uses of mathematics in everyday living, man's occupations, and art work.

After each topic discussed in Chapter III which lends itself to supplementary reading and study the writer has included an annotated bibliography for the pupil's use.

The Stereoscope

The use of the stereoscope.-- The stereoscope is an old-fashioned piece of visual apparatus that may be found in many an ancient parlor desk. Its value lies in the fact that it gives the observer a sense of three dimensions. Its use in the mathematics class is limited due to the type of stereographs available. Some of the stereographs of Greek and Roman architecture will provide good examples of the use of solid

1/A. Neely Hall, Home Handicraft for Boys, J. B. Lippincott Company, Philadelphia, Pa., 1935.

2/Ruth M. Hall and A. Neely Hall, Home Handicraft for Girls, Junior Literary Guild and J. B. Lippincott, New York, 1941.

3/Harold Rugg and Louise Krueger, Man at Work: His Arts and Crafts, Ginn and Company, Boston, 1937.

geometric figures. Keystone View Company[1] sells stereographs ranging in price from twenty-seven cents to seventy-five cents each.

1/Keystone View Company, Meadville, Pa.

CHAPTER III

SIX TOPICS WITH EXAMPLES OF THE USES OF VISUAL AIDS

Mathematics in Everyday Life

Objectives to be realized.-- Everywhere the pupil turns he finds evidences of the use of mathematics. It is important to his life and well-being. He and his family often use certain phases of it.[1] To make his school work in mathematics real and meaningful he must be made aware of the important part mathematics plays in his life. Paul R. Hana[2] writes:

> The committee believes that some facility in arithmetic is indispensable to the life of any normal child. Each week brings scores of situations in which a child must make use of numbers to carry on his work and play: he must be able to count his marbles or the number of children invited to his party; to measure the ingredients for a batch of candy, or the length, width, and thickness of the board for a model ship; to handle money in his purchases at the store, or to add up the cost of his lunch or total the cost of an order for stamps; to divide equally, or otherwise, the contents of a bag of fruit among his friends, or apportion the cost of an entertainment among the members of a group; to keep the moving hands of the clock in mind in order to terminate the music practise or to know

1/The most frequent uses are listed in What Arithmetic Shall We Teach? by Guy Mitchell Wilson, Houghton Mifflin Company, 1926, pp. 30-38.

2/The National Council of Teachers of Mathematics Tenth Yearbook, Bureau of Publications, Teachers College, Columbia University, New York, 1935, p. 85.

> when it is time to hasten home to eat; to differentiate between more and less, larger and smaller, heavier and lighter, etc. For these and countless other everyday activities in school and out, children use number to solve their difficulties and promote their interests. Arithmetic is, as we have said, indispensable.

Use of visual aids in realizing the above objectives.-- A few of the following may be used as an introduction to a course in junior high mathematics, or several of them may be used throughout the year to keep this important idea before the pupils.

Bulletin-board material.-- Posters may be made by the pupils showing the uses of mathematics in business, the home, the school, or the playground. These may be freehand drawings or pasted clippings. The writer has received posters of a baseball diamond with its dimensions, a teller receiving a deposit at the bank, a clerk making change at the store, the family's monthly bills pasted on a sheet of construction paper. In one city a woman's club[1] offered a prize for the best poster on the importance of mathematics, and exhibited a number of the entries in a store window.

The Museum of Science and Industry[2] in Chicago sells a chart entitled "The Tree of Knowledge" for twenty-five cents. Small prints may be obtained from The Mathematics Teacher[2] for five cents. The diagram represents a tree with its basic

1/The Mathematics Teacher, National Council of Teachers of Mathematics, New York (January, 1945), 38: 38.

2/See appendix for address.

root labeled mathematics and the other roots and branches marked with branches of science and industry depending upon mathematics.

Opaque projection.-- Magazine and newspaper pictures may be flashed on the screen to see what uses of mathematics the pupils can find evidences of in these scenes of everyday living. From a picture of a gasoline station, for example, might come a discussion of the price of the gasoline, the taxes involved, the need to figure how much the driver's tank will hold, and the amount he can purchase on his ration tickets, the meaning of thirty-two pounds of air for his tires, the oil gauge, and the cost of oil. Some pupils would be interested in reporting information about the cost of running a station and the problem of storing the fuel.

Lantern-slide projection.-- Those interested in photography may be encouraged to take pictures of things about the town that suggest uses of mathematics. These photographs may be printed on sensitized glass and shown in the projector.

Homemade slides may be drawn and colored by the pupils to illustrate common uses of mathematics. Examples of these would be a bridge, a gasoline station, a store, a train, a theater, or a garden. When the pupil's slide is shown he would be expected to explain the uses of mathematics suggested to him. For example, the boy showing the train slide

might explain the cost of travel in coach and pullman, the miles of track needed, the maps and timetables printed, the expense involved in repairing or running engines, the amount of coal and water used, the cost of ice for air conditioning, the freight rates and insurance rates.

Film strips.--[1] "Mathematics and the Pilot," a four-dollar film strip put out by Jam Handy,[2] stresses the importance of mathematics to the pilot.

"Is Seeing Always Believing?" a film strip put out by the Society of Visual Education[2] in Chicago selling for two dollars, deals with optical illusions. This company also has one at the same price on clocks entitled "Timekeepers Through the Ages."

Motion pictures.--[1] Jam Handy puts out a 16 mm. sound film that runs for ten minutes and sells for $36.50, entitled "A Thousand Hours." This deals with pilot training and encourages boys to make the most of their high school mathematics.

Books for the bookshelf.--

Barry, Ruth, The Wise Consumer, Row Peterson and Company, Evanston, Illinois, 1942. 48 pp.
This book, on the problems of the consumer, is very cleverly written and would hold the pupil's interest. The illustrations are of the cartoon type and very pointed in their message.

1/The material here has not been reviewed by the writer. She has included it because it is available material that a teacher might be able to use.

2/See appendix for the address.

Britton, Katharine, What Makes It Tick? Houghton Mifflin Company, Riverside Press, 1943. 226 pp.
This book explains many things of interest to boys and girls. Some of the topics discussed are electricity, gears, telephones, milk, storms, snow, trains, boats, cameras, movies, warplanes, and submarines. In explaining their uses and constructions the author touches upon measurement, size, speed, costs, and distances.

Foster, Constance J., This Rich World, Robert M. McBride and Company, New York, 1943. 158 pp.
This is an interesting book on the story of money and its uses. The last four chapters deal with banking, spending, saving, taxes, and the waste of war. An excellent book.

Frost, Edwin Brant, Let's Look at the Stars, Houghton Mifflin Company, New York, 1935. 118 pp.
This book contains interesting information about the stars, planets, and constellations we can see. Mathematics is used in explaining distance, time, size, and the use of the telescope.

Hamilton, Edwin T., Trick Photography, Dodd, Mead and Company, New York, 1938. 139 pp.
This book gives clear directions on taking trick pictures. Much of the fun results from a study of proportion.

Rue, Flora C., From Barter to Money, Row Peterson and Company, Evanston, Illinois, 1941. 36 pp.
This book contains interesting short stories of how our money came to be. It is not as complete a story as This Rich World. The illustrations are in color and are well done.

Spencer, Lyle M., and Robert K. Burns, Youth Goes to War, Science Research Associates, Chicago, 1943. 223 pp.
This book describes the work and training required of our men and women in the service. It also tells of training needed for the home front work. The last section of the book stresses the importance of high school training in order to fit oneself for work after victory.

Teale, Edwin Way, The Boys' Book of Insects, E. P. Dutton and Company, New York, 1939. 234 pp.
This book contains excellent descriptions of insects and their ways of living. There are a number

of enlarged photographic prints and many scale drawings of things to construct such as an ant house and an aquarium.

Waltz, George H., Jr., What Do You Want to Be? Henry Holt and Company, New York, 1939. 237 pp.
This book contains excellent descriptions of fourteen occupations for boys, stressing training needed, range of salaries, work required, and possibilities for advancing.

Counting and Measuring

Objectives to be realized.-- Our present systemsof counting and measuring have developed through the centuries as man has found need for them.[1/] Today we make use of them in our everyday living many more times than we realize. The pupil should understand the meaning and uses of linear, square, and cubic measure.

Use of visual aids in realizing the above objectives.-- It would not be advisable to use all of the following aids in any one class, but a few from those suggested would stimulate interest in counting and measuring and give the pupils an opportunity for independent work on a project of interest to them.

Models.-- The writer recommends the making of this first model only after the pupils have a clear understanding of the use of scale drawing. From a board that is six feet long and six inches wide a large ruler may be made and marked off to

1/David Eugene Smith, History of Mathematics, Vol. XI, Ginn and Company, Boston, 1925, pp. 36-88.

the scale of one foot to one inch so that an eighth of an inch may be seen from any position in the room. The reverse side of the ruler may be marked off in centimeters and millimeters drawn to scale with the tenth centimeter marked in red to denote a decimeter. After the ruler has received a coat of shellac it will be a pleasant addition to any mathematics classroom and will be available for reference at any time.

A time candle is made by burning one of two similar candles and then coloring alternate sections of the other candle for each length burned every half hour.

An abacus may be made from wood or wire or a combination of both to illustrate one of the early methods of counting. The model may be copied from pictures found in books giving the history of mathematics.[1] Frank M. Rich[2] describes how an abacus may be made from a handkerchief box and beads or large seeds. He recommends its use in learning and practising the number combinations.

In order to visualize the units of cubic measure, models of a cubic inch, cubic foot, and a cubic yard may be made of wire. The writer received a foot cube made of newspaper and paste. It was fragile but hung from a silk thread and served

1/Vera Sanford, A Short History of Mathematics, Houghton Mifflin Company, Boston, 1930, p. 87.

2/Frank M. Rich, "Pepper Relish," The Journal of Education (March, 1945), 128:88.

its purpose when the pupil compared it with an inch cube he had cut from wood.

Classroom museum.-- A very interesting exhibit may be arranged by the pupils with instruments of measure they and their families may possess. Their mothers will provide tape measures, knitting needle gauges, minute glasses, and measuring cups and spoons. Their fathers will have instruments less commonly known. What they will be will depend largely upon the occupations represented in the group. One boy in the writer's class claimed to be a lobster man and exhibited a device for measuring the size of lobsters--a practice required by law.

Bulletin-board material.-- Individuals in the group may make posters illustrating the uses of measure in everyday life or the uses of measure in man's work. Posters of this kind may include a draftsman at work, a football field, scales, or a speedometer.

Ford Motor Company puts out a free pamphlet in color entitled "How Long Is a Rod? Historical Review of the Measurement of Length." Besides some excellent illustrations of historic methods of measure including a rod, cubit, pace, span, yard, and inch, there are seven comparisons stated in answer to the question, "What is 1,000,000th of an inch?"

Charts may be made for the bulletin board or blackboard to show comparisons of the early Egyptian, Babylonian, Roman,

and Arabic numerals.[1]

Film strips.-- Jam Handy Organization sells the following film strips at four dollars each. The writer has reviewed these films and used part of them. It is her opinion that the strips as a whole are too advanced for a junior-high-mathematics class, but several of the pictures in each strip are very good and can be shown without using the whole roll. The films are "Units of Measurement" which includes pictures to illustrate the English system and the metric system as well as some more advanced work, and "Measurement and Measuring" which comes in two parts: part one takes up standards of measurement, work accuracy, dividers, and calipers; part two deals with the micrometer.

The Society of Visual Education in Chicago sells the following film strips[2] at two dollars each: (1) "The Story of Figures," (2) "History of Measurement of Length," and (3) "Timekeepers Through the Ages." The latter is a film about clocks.

Opaque projections.-- Pictures from magazines, books, and newspapers may be placed in the opaque projector and flashed on the screen to show occupations depending upon

1/David Eugene Smith, Number Stories of Long Ago, Ginn and Company, Boston, 1919, p. 136.

2/The material here has not been reviewed by the writer. She has included it because it is available material that a teacher might be able to use.

measurement, or everyday uses of counting and measuring. In order to stimulate interest in some of the books on the bookshelf, the teacher can show some of the illustrations from them in this projector.

Motion pictures.-- The Visual Education Service in Boston rents for $1.50 a one-reel sound film entitled "Origin of Mathematics."[1/] This film shows the symbols and processes used in the past by cave dwellers, Egyptians, Babylonians, Greeks, Romans, and Arabs.

The Ideal Picture Corporation in Chicago rents 16 mm. sound moving pictures on the precision instruments. This group of films has not been reviewed by the writer. Most of them are probably too advanced for junior high boys and girls, but they are being included in this paper with the suggestion of possible use where a pupil might plan to make a report on one of the instruments described. The following are available: "The Steel Rule," time 12 minutes, fee $1.00; "The Micrometer," time 15 minutes, fee $1.50; "Fixed Gages," time 17 minutes, fee $1.50; "Vernier Scale," time 19 minutes, fee $1.50; "High Gages and Standard Indicators," time 11 minutes, fee $1.00.

The mathematics class work can be correlated with the shop work in a study of the two reel 16 mm. sound motion

1/This material has not been reviewed by the writer.

picture "Behind the Shop Drawing" put out by Jam Handy. It deals with the importance of shop drawings and shows how they are made. It also gives information about blueprints. The writer found that the boys who were taking practical arts appreciated the film far more than the other members of the class.

General Electric loans a film #2371 "When You Can Measure."[1/] This is a 16 mm. sound film and runs for thirty-six minutes. It explains electrical measuring instruments and shows their development.

Books for the bookshelf.--

American Council on Education, Committee on Materials of Instruction of the Americal Council on Education, Washington, D. C., 1932. The Story of Writing. 64 pp. The Story of Numbers. 32 pp. The Story of Weights and Measures. 32 pp. The Story of Our Calendar. 32 pp. Telling Time Throughout the Centuries. 64 pp.

These five little books are well written and well illustrated to interest the junior high school child. They contain excellent material.

Burroughs Adding Machine Company, The Story of Figures, Burroughs Adding Machine Company, Detroit, 1928. 28 pp.

This booklet is sent free of charge upon request. It is an interesting story of figures with special stress on the development of mechanical figuring, Chapters X-XIII dealing with the work and success of William Seward Burroughs.

Meyer, Dickey, How Planes Get There, Harper and Brothers, New York, 1944. 64 pp.

This book gives a very good description of how a pilot can keep on his course. Diagrams and explanations of the instrument board, compass, use of angles, drift, and speed are a few of the things included.

1/The material here has not been reviewed by the writer. She has included it because it is available material that a teacher might be able to use.

Smith, David Eugene, Number Stories of Long Ago, Ginn and Company, Boston, 1919. 136 pp.

This book contains a great deal of information about our number system that would be of interest to this age group. The style of writing seems more elementary than most of the books listed and should meet a need especially for the poorer reader.

_____, The Wonderful Wonders of One-Two-Three, McFarlane, Warde, McFarlane, New York, 1937. 47 pp.

This book is well written and illustrated for younger children but contains information of interest to the junior-high age.

_____, and Jekuthiel Ginsburg, Numbers and Numerals--A Story Book for Young and Old, Bureau of Publications, Teachers College, Columbia University, New York, 1937. 52 pp.

This is a little book similar to the above but written for older young people. It may be obtained from the publishers for twenty-five cents. The illustrations are excellent.

Percentage

Objectives to be realized.-- The term "per cent" according to Webster's dictionary is an "amount or quantity measured by the number of units in proportion to one hundred." Because the consumer meets percentage in many phases of business such as in discounts, down payments, taxes, commissions, content of material, and interest rates, it is important that the young consumer be able to compute and interpret these percentages used in everyday living. Hugh Stelson, 1/ in his book on The Mathematics of Business, devotes a full chapter to the study of percentage.

1/Hugh E. Stelson, The Mathematics of Business, Houghton Mifflin Company, Boston, 1940.

The use of visual aids in realizing the above objectives.-- It is the writer's opinion that the more the pupil handles illustrative material on percentage, the easier it will be for him to use percentage in computation. Therefore in this unit she feels that the most valuable aids are those made or compiled by the pupil.

Bulletin-board material.-- In order to help the pupil understand the dictionary definition that "per cent" is an "amount or quantity measured by the number of units in proportion to one hundred," have him box in on checked paper[1] one hundred squares to represent 100 per cent; then have him shade in six of the one hundred squares and label it "6 per cent shaded." In another box of one hundred squares ten may be shaded to represent 10 per cent.

In order to emphasize the fact that percentage is figured on the basis of one hundred, have the pupil block off several boxes containing different numbers of squares; for example, one of ten squares, another of fifteen squares, another of fifty squares, and one of thirty squares. Shade in enough squares in each block to represent the same percentage in each case. In this example let us use 20 per cent. Then two of the ten squares would be shaded, three of the fifteen, ten of the fifty, and six of the thirty would be shaded and each

1/William Betz, Everyday Junior Mathematics Book, Ginn and Company, Boston, 1944, p. 152.

block would be labeled "20 per cent shaded."

In order to show that the percentage depends upon the whole amount as well as the shaded section, have the pupils block off boxes of twenty, fifteen, thirty, fifty, and one hundred squares and then in each block shade in the same number of squares, for example ten; then label blocks correctly. The above blocks with ten shaded squares would be labeled 50 per cent, 66 2/3 per cent, 33 1/3 per cent, 20 per cent, and 10 per cent respectively.

Pictographs may be drawn giving information in percentage about things of interest to the pupil. For example, to picture the percentage of pupils in the school buying war stamps, let each figure represent 10 per cent. If 90 per cent of the pupils buy, draw nine figures purchasing stamps and one figure standing empty-handed or eating an ice cream cone. Another chart might show the percentage of pupil participation in sports for boys and for girls. Those participating might be drawn with a ball and the others, seated or standing idle.

Bar graphs may be made showing percentage of attendance each month, or class percentage purchasing war stamps each week.

To illustrate the meaning of the fractional equivalents one may draw bars on checked paper ten squares long and shade in parts of them; for example, shade in half the bar and

label it "one-half or 50 per cent," shade in one-fifth of the bar and label it "one-fifth or 20 per cent."

Display newspaper clippings illustrating the different uses of percentage in the daily news. The writer had one pupil bring in ten entirely different uses clipped from the newspaper. They were discount, as 10 per cent discount on goods; down payments, as 25 per cent down payment required; taxes, as 20 per cent tax on bags; general comparisons, as 10 per cent whiter; batting averages for baseball teams; content of material, as 50 per cent cotton, 50 per cent wool; interest rate; statistics on decrease of certain diseases; commission offered salesmen; and percentage of profit in sales.

Charts, graphs, cartoons, and posters may be made by pupils to illustrate uses of percentage that seem important to the individual. Some of this work can be correlated with the pupil's work in art. For example, a drawing of a boy running to school as the last bell is ringing might have the caption, "98 per cent of our school come on time. Do you?"

Classroom museum.-- Exhibit things that show practical and tangible evidence of the uses of percentage such as a cereal box that tells the percentage of sugar, wheat, and other ingredients; clothing labels telling the percentage of wool; price tags with tax rate; and replicas of models and signs that pupils have seen in stores, offices, banks,

factories, or on buses such as "Fire sale 25%-50% off."

Opaque projection.-- Flash on the screen any material from books, magazines, newspapers, or any other reading matter that shows illustrations that will help to clarify the pupil's concept of percentage. Other textbooks of the same grade level as the class textbook are useful for this purpose.

Flashometer.-- A flashometer is an attachment that can be purchased for the lantern slide projector. With it a number, equation, or sentence can be flashed on and off the screen in a fraction of a second. The length of time that the number remains on the screen can be adjusted. With the flashometer a pupil may get some individual drill on fractional equivalents, changing per cents to decimals and decimals to per cents, or rounding off numbers to the nearest tenth of a per cent.

Lantern-slide projection.-- Pupils may draw a series of congruent figures and shade in part of them to represent a certain percentage of the whole. For example, four equal circles could be drawn in a row and one shaded in to represent 25 per cent.

The suggestions listed under bulletin board material could be put on slides if the teacher preferred to have it presented in that manner.

A series of slides may be made by the pupils to show

uses of percentage in business. Each pupil would explain his slide as it appeared on the screen. A picture of a boy on his paper route might be suggestive of commission, and a bank book or a bank teller's window, of interest.

Graphs

Objectives to be realized.-- In order to bring a fact before the public clearly and quickly a person may state his story in graphic form. One should be able to construct as well as read and interpret a simple line, bar, circle, and pictograph. In Chapter IX on "The Reorganized Mathematics of the Junior High School," Hassler and Smith write:[1/]

> ....Twenty-five years ago the average person needed no knowledge of graphs in his ordinary reading. If statistics showing the trend of prices were presented, or a comparison of the standing armies of the different nations made, or a report on the distribution of the tax money to different departments of the government printed, he saw it all in columns of figures. Now he sees the trend of prices represented by a broken line graph showing rise and fall. He probably sees the standing armies compared by means of a pictogram representing by the heights of soldiers (each in the uniform of his nation) the relative sizes of the standing armies; or, which is not so misleading, by means of a bar graph, that is, a series of shaded lines representing by their relative lengths the sizes of the various armies. He probably sees the relative costs of the various departments of government represented by a circle graph where sectors of a circle show relative amounts disbursed by the departments, the whole circle representing the entire tax collected and disbursed. The circle may represent a dollar and the

1/Jasper O. Hassler and Rolland R. Smith, The Teaching of Secondary Mathematics, The Macmillan Company, New York, 1930, pp. 201-202.

> graph be entitled "Where the taxpayer's dollar goes." Not all these graphs which strike the eye of the reader are easily interpreted by one of no experience with them. They must be understood if he is to read intelligently. The conclusion is obvious--pupils must be taught in school the meaning of these things. In no other course does this subject matter fit more aptly than in the course in mathematics.

Bulletin-board material.-- With this unit there is a great deal of opportunity for correlation with other school subjects. Graphs of population, distribution or production of goods, relative speeds of public conveyances, might be worked from social studies problems. Graphs of progress on spelling tests could enter the English class. Graphs showing percentage of wool in clothing or amounts of fats and proteins in foods would fit into the household arts program. Graphs may be made for exhibit purposes in many fields of study and in many other phases of school life as well, such as graphs of the boys' batting averages, classes' receipts for Red Cross drive, class participation in school activities such as assemblies, traffic squad, school paper, class sports.

Graphs cut from newspapers and magazines will illustrate their importance and use in the world about us. Try to have the pupil find graphs pertaining to things within his scope of knowledge, for graphs about things that are meaningless to the pupil will defeat the purpose for which they are exhibited.

The Metropolitan Life Insurance Company publishes graphs in leaflet form dealing with statistics on health and insurance

risks. Local concerns often have graphic material they will loan teachers on request. A teacher should acquaint herself with the community in which she works and take advantage of what the local industries have to offer.

Film strip.-- Jam Handy sells a slide film from Kit IV entitled "Graph Uses." The price is four dollars.

Opaque projection.-- Graphs may be placed in the opaque projector so that all pupils will see the same graph at the same time. The teacher or class members may point out the important things for correct graph reading and interpreting. With one large projection and a pointer the teacher can be reasonably sure that everyone is looking at the same line at the same time.

The newspaper graphs that the children have brought in may be shown on the screen and explained by the pupils bringing them.

Lantern-slide projection.-- A series of slides may be made by the teacher showing each step in the process of making a line graph or a bar graph. If the room is only semi-dark the pupils may carry out each step on paper as it is explained from the large graph on the screen.

Books for the bookshelf.--

Annual reports from companies such as General Motors usually have excellent graph material in them. These are in the possession of the stockholders and the children will bring them in if requested.

The Picture Fact Associates, Alice V. Keliher, editor, publishes through Harper and Brothers, New York, 1939-1941, a series of small books on occupations. There are fifteen of them describing fifteen different occupations. They discuss requirements for fitting oneself for the occupation, possible wage scales, and work expected. Some of the information is emphasized by the use of graphs. Some of the book titles are Doctors at Work, Railroad Workers, Radio Workers, Nurses at Work, and Farm Workers.

Scale Drawing

Objectives to be realized.-- For practical use many plans, diagrams, and models such as house plans, boat models, road maps, dress designs, and magazine illustrations, are drawn to scale. It is often necessary to use enlarged drawings, pictures, or models so that one can see more clearly the tiny details of the original. This is true of pictures of the skin, illustrations in articles on insects, diagrams for crocheting or knitting instructions, and motifs for design. Some material is enlarged so that it may be seen easily from a distance. This is true in the motion picture industry, and on charts and posters. The pupil should be able to construct things to scale and interpret scales found in material used by him.

The use of visual aids in realizing these objectives.-- Illustrative material made by the pupil will serve for demonstration material and will give the pupil firsthand experience in making use of a scale. Close correlation with other studies is possible if scale drawings in woodworking plans, pictures

and designs in art, social studies maps, diagrams from industry studied in science, and models in biology are exhibited or drawn by the pupil while this unit of work is being studied.

Bulletin-board material.-- Practical uses of scale drawing will become evident as bulletin-board material comes in from pupils. Some will have house plans, victory garden plans, model airplane plans, or road maps.

Scale drawings of things the boys and girls are doing in other studies and in their leisure time will make good bulletin-board material. Wall paper designs in art, scale drawings of an early colonial village, or a map of the territory explored by early traders, or a map showing the division of land, scale drawings of costumes worn in various periods in the development of our country, drawings of the homes or countries of some of the characters in the English reading books, a map locating the Gold Bug treasure, plans for model airplanes and boats, plans for projects in practical arts such as cabinets, lamp stands, or tie racks, scale drawing of a girl's room with the furniture placed in it, science diagrams to explain the cause of a spring, or the workings of a lift pump are a few suggestions for correlation.

More interest may be stimulated by allowing pupils who draw house plans to make blueprints of them. The material can be purchased reasonably if it is not available from the

science laboratory. M. W. Sperks[1/] tells how his class made notebooks in which were included a scale drawing of a home and another of a map of the village in which the home was located. The scale drawing was only a small part of the whole problem, but it was a necessary part.

Models and museum material.-- Models may be made of wood, clay, or paper to illustrate work studied by the pupil. A model of a water wheel for science, or a model of an Indian dwelling for social studies, a number of pieces of doll's furniture to illustrate types used in different periods, are a few of the things that can be done. Large models of small things studied in science might be attempted. Examples of these would be a fly's leg, snow crystals, or parts of a flower. Careful attention must be given to the accuracy of the scale in every detail.

The things pupils bring in will show how frequently we use things made to scale in our lives. Motion picture film, dress designs, table models used for decorative purposes in the home, model airplanes and boats, are only a few of the possibilities for display.

Public museum material that can be borrowed will depend largely upon the teacher's location. He should inquire about the loan services rendered by local museums. Museums often

1/M. W. Sperks, "Determination of Taxes in the Community," School Science and Mathematics (May, 1942), 42:454-462.

have exhibits to loan[1] that are made to a very accurate scale. They may show types of Indian dwellings, or the home of the beaver, or types of transportation, but the more varied the topics the more the pupil will realize the extent to which scales may be used.

At the University Museum in Cambridge there is an excellent exhibit of glass flowers. Each part of the flower is modeled to a large scale. This and similar exhibits that the teacher may find in nearby museums may be called to the pupil's attention. Some individuals may want to report on the display or a group may plan a trip to the museum.

The pantograph.-- The pantograph is an instrument used to draw figures to scale, and to enlarge or reduce maps, drawings, and designs. It consists of four bars fastened together in such a way that the four pieces form a parallelogram, two adjacent sides of which are extended at opposite ends to form a long and a short arm. If the drawing is to be enlarged the short arm is made stationary and the pencil is at the end of the long arm. If the drawing is to be reproduced in miniature, then the long arm would be the stationary one and the pencil placed at the short one. For diagrams and further information see The Mathematics Teacher.[2]

1/See Business Education World (March, 1945), 25:369 for list of museums that render such service.

2/The Mathematics Teacher, National Council of Teachers of Mathematics, New York (November, 1939), 32:321.

Film strips.-- Jam Handy sells a film strip for four dollars entitled "Scales and Models" which tells the story behind scale drawing, discussing both larger and smaller productions and giving information on how to plan and understand them.

Motion pictures.-- The Y.M.C.A. loans for $1.50 a one-reel film entitled "The Draftsman."[1/]

Jam Handy has a 16 mm. sound film of two reels entitled "Behind the Shop Drawing" which stresses the importance of shop drawings, shows how they are made, and explains blueprints.

Books for the bookshelf.--

Cooke, David C., and Jesse Davidson, The Model Plane Annual, Robert M. McBride and Company, New York, 1943. 224 pp.
For the boy with a hobby for model planes this is an excellent book. The illustrations are clear. The book contains information about the engines, and power of the planes, and shows models used for cadet training as well as the plans and pictures of planes built by boys in the Model Airplane Club.

Gilmore, H. H., Junior Boat Builder, The Macmillan Company, New York, 1938. 87 pp.
This book contains plans for models of thirteen different types of boats as well as plans for a lighthouse, buoy, wharf, and ferry dock. Complete directions are included with each plan.

Hall, A. Neely, Craft Work-and-Play Things, J. B. Lippincott Company, Philadelphia, 1936. 246 pp.
This book gives plans and directions for many things such as model railroad, theater, dollhouse, and furnishings, airplanes, airport, boathouse and boats. All the suggestions have been tried and proved satisfactory.

1/The material here has not been reviewed by the writer. She has included it because it is available material that a teacher might be able to use.

_____, Home Handicraft for Boys, J. B. Lippincott Company, Philadelphia, 1935. 292 pp.
This book is filled with quantities of suggestions of things a boy can make at very little expense. There are scale drawings for most of the articles with complete explanations as to procedure.

Hall, Ruth M. and A. Neely, Home Handicraft for Girls, Junior Literary Guild and J. B. Lippincott Company, New York, 1941. 359 pp.
This book is filled with quantities of suggestions of things a girl can make at very little expense. There are scale drawings for many of the articles with complete explanations as to procedure.

Headstrom, Richard, Adventures with a Microscope, Frederick A. Stokes Company, New York, 1941. 232 pp.
This book contains excellent illustrations of things as they look when viewed through a microscope. The text is well written for a junior-high-school pupil making the whole study appear to be an adventure in the study of tiny things.

Jenkins, Dorothy H., The Children Make A Garden, Junior Books, Doubleday Doran and Company, New York, 1936. 70 pp.
This book appears to be written for children. It has excellent garden plans drawn to scale and many fine illustrations. It is a good book for the poor reader.

Wodell, Helen Page, Beginning to Garden, The Macmillan Company, New York, 1928. 104 pp.
This book has some garden diagrams from which the pupils might get ideas for their own gardens. The text is not attractive to the writer but she feels that it would have a place on the shelf as a reference book for those interested in gardening.

Yates, Raymond F., How to Make Electric Toys, D. Appleton-Century Company, New York, 1938. 199 pp.
This book is for the more advanced pupil giving plans and directions for making things like an electric microphone, an air-rifle target, a secret magnetic lock, and an alarm clock.

Geometry

Objectives to be realized.-- Roy O. Billett[1] writes:

> ....each of the subject-matter fields is elementary enough to extend down to the nursery school, and complex enough to include the farthest upward and outward reaches explored by professional workers, by university workers at the research level, and by all other creative workers.

A study of intuitive or informal geometry is recommended for junior-high-school pupils as an appreciation and exploratory course[2] giving the pupil a background for work to follow and general information that every well-read citizen should have. The work should include an informal study of the geometric figures in common use, including recognition, drawing uses, and construction; a development of space concepts; direct and indirect measurement; finding of perimeters, areas, and volumes; noting relationships by experimentation rather than by formal proof.

Use of visual aids in obtaining these objectives.-- Since in many schools this will be the pupils' introduction to geometry, the use of visual aids should be employed as much as possible to help present to the pupil the new concepts and ideas that are basic to the study.

Models.-- A very popular suggestion for optional work is

1/Roy O. Billett, Fundamentals of Secondary-School Teaching, Houghton Mifflin Company, Boston, 1940, p. 161.

2/Ernst R. Breslich, Problems in Teaching Secondary-School Mathematics, University of Chicago Press, Chicago, 1940, p. 255.

the making of models. Cardboard cut-outs of the plane figures are very decorative and may be used in drill work for mastery of recognition.

Models of the solid figures such as cubes, rectangular solids, cones, prisms, and cylinders may be made from cardboard, wood, modeling clay, or wire. In many schools arrangements can be made to have the wooden models made in the shop by boys taking both mathematics and practical arts.

A quantity of inch cubes will help in the explanation of volume.

Several empty models of rectangular solids of different shapes but of equal volume may be made and one of them filled with sand. By pouring the sand into each of the others the pupil will see that the volumes are the same even though the shapes may be different.[1] He can also prove in this manner that it will take three cones full of sand to fill a cylinder of equal base and height. Such exercises will help in an understanding of the formulas for volume.

In Spokane, Washington a mathematics class[2] took full charge of decorating a school Christmas tree. They made geometric figures from cardboard and painted them, sprinkling

1/Jasper O. Hassler and Rolland R. Smith, The Teaching of Secondary Mathematics, The Macmillan Company, New York, 1930, p. 209.

2/Kate Bell, "Mathematics and Christmas," The Mathematics Teacher (January, 1945), 38:363-364.

tinsel on the wet paint to add luster. Long slim pyramids for icicles, spheres for snowmen, and bright prisms were made by many pupils, but the more enthusiastic students learned about polyhedrons and made bright glistening stars. The work was so successful that later classes were asked to trim trees for veteran hospitals.

Museum material.-- Reports may be made on uses of geometry that pupils have seen in local architecture or in museum exhibits. In the New National Gallery of Art in Washington, D. C., for example, there is a rotunda with a fountain surmounted by a bronze statue of Mercury. The number of circles used in the planning of the rotunda is worthy of comment. Similar illustrations at local museums and other buildings will be found by the resourceful pupil or teacher.

A classroom exhibit of articles resembling geometric figures may be arranged by the pupils. They can bring in the material and arrange it according to the shape; for example, a group labeled "spheres" might include various kinds of balls, the globe, berries, a crystal ball, beads, marbles, sour ball candies, seeds, imitations of a snowball, orange, grapefruit, and hailstones.

Bulletin-board material.-- Pupils may make posters illustrating the geometric figures studied or posters showing uses of these geometric figures in nature, home furnishings, or

other phases of everyday living. A poster entitled "Cubes" might include pictures of baby blocks, ice cubes, dice, diced vegetables, a hat box (if cube-shaped), or sugar cubes. A picture of a room might be mounted on construction paper and have things in it numbered with a key below listing the geometric figure each item in the picture resembles; for example, a book resembles a rectangular solid, the rug a rectangle, the table top a circle.

With a compass and straight edge have pupils make designs suitable for wallpaper, rugs, table covers, dress goods, curtains, or other things of their choice.

Opaque projection.-- Pictures of modern homes and their interiors may be flashed on the screen for pupils to point out the geometric figures in their construction or decoration. Clippings that children have brought in may be shown while each child explains his reasons for selecting the particular picture he chose.

Motion pictures.-- Visual Education Service in Boston has a 16 mm. sound film that sells for thirty dollars and rents for $1.50. It runs for ten minutes giving an introduction to the study of geometry and showing many uses and evidences of it in our world. The film is called "Geometry in Action." "Mysteries of Snow" is put out by the same company. It shows drawings and photomicrographs of snowflakes. It is a 16 mm.

silent film of less than one reel.

If the teacher can attend a local motion picture that she is sure many of her class will see, she can suggest that they look for uses of geometric design in it or mention special scenes in it for them to notice. The same might be done with an assembly motion picture if it did not interfere with the original purpose of the showing.

Lantern-slide projection.-- After the pupils have made a lantern slide of each geometric figure to be learned a game may be played by dividing the class into two groups. One member from each side is up. As a figure is shown on the screen the two contestants name it. The first one naming it correctly continues to be up and the next person on the other side is up. The whole class sees the figure and hears its name. This is a pleasant and fairly rapid way of having the class learn the names of the figures in varied positions and different sizes.

Stereograph material.-- Many of the stereographs of the Greek and Roman buildings will prove to be excellent illustrations of geometry in architecture. If a school does not have a stereoscope it is possible that some of the grandparents of the children will and with it the stereographs.

Film strips.-- The Society of Visual Education in Chicago sells the following for two dollars each: "Is Seeing Always Believing," "Geometry in Nature," "Geometry in the Home,"

"Geometric Solids in Nature and Architecture." Although the writer has not reviewed the above she believes that they are of value in the teaching program. The society also has five film strips on rectilinear figures and three on the circle. If the strips were available, some frames might be of use but by and large these would be too advanced for junior-high classes.

Jam Handy has seven film strips in Kit II of the Light on Mathematics series which are too advanced but could be used in part if they were available to the teacher.

Books for the bookshelf.--

Allen, Phoebe, Peeps at Architecture, A and C Black Ltd., London, 1924. 86 pp.
This book has good illustrations showing the geometric figures and designs in architecture. The text gives interesting stories and information about the different types shown.

Bently, Wilson A., Snow Crystals, McGraw-Hill Book Company, Inc., New York, 1937. 227 pp.
This book contains hundreds of photomicrographs of snowflakes. Excellent photography and geometric design is shown.

Borman, Henry H., Bridges, The Macmillan Company, New York, 1934. 78 pp.
This book contains excellent photographic illustrations and diagrams of many different types of bridges.

Conklin, Croft, All About Houses, Julian Messner, Inc., New York, 1939. 194 pp.
This book tells the story of how a house is built, the trades involved in the building, designs and plans necessary, and the tools and equipment required. It has excellent illustrations including blueprints.

Lamprey, L., All the Ways of Building, The Macmillan Company, New York, 1933. 304 pp.
This book gives descriptions and illustrations of houses all over the world. It should be of interest to many.

Mangard, Adolfo Best, A Method of Creative Design, Alfred A. Knopf, New York, 1937. 183 pp.
The illustrations are excellent for all. The text will interest only the better students interested in art. The book is filled with geometric illustrations.

Robinson, Ethel Fay, and Thomas R. Robinson, Houses in America, The Viking Press, New York, 1936. 240 pp.
Pictures and information about houses and house plans from early America up to the present time are included in this book.

Addresses of Sources for Material Listed in This Paper

Burroughs Adding Machine Company, Detroit, Michigan

The Ideal Picture Corporation, 28-34 East 8th St., Chicago, Ill.

Jam Handy, 2900 East Grand Blvd., Detroit, Michigan

Keystone View Company, Meadville, Pennsylvania

The Mathematics Teacher, 525 West 120th Street, New York City

Metropolitan Life Insurance Company, 1 Madison Ave., New York City

Museum of Science and Industry, Jackson Park, Chicago, Illinois

Society of Visual Education, 100 East Ohio St., Chicago, Ill.

Teaching Aids Service, Jamaica Plain, Mass.

Visual Education Service, 131 Clarendon St., Boston, Mass.

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Billett, Roy O., Fundamentals of Secondary-School Teaching. Houghton Mifflin Company, Boston, 1940. 671 pp.

This is a book to be studied in order to learn how one subject can not be taught by itself but must be integrated with the pupil's whole school experience. On page 161 the author says, "....no natural boundaries separate the several subject-matter fields one from another. They are parts of a whole cloth woven on the loom of human experience."

Breslich, Ernst R., Problems in Teaching Secondary-School Mathematics. University of Chicago Press, Chicago, 1940. 348 pp.

This is a reference book of value for all secondary-school mathematics teachers. It deals with material to be taught and reasons for teaching it. The writer includes it in this bibliography for without guidance in objectives and material no one can make the use of visual aids effective.

Dorris, Anna Verona, Visual Instruction in the Public Schools. Ginn and Company, Boston, 1928. 481 pp.

This book gives background material on the functions and uses of visual aids in general. There is no specific material here for mathematics, but much that is written may be used indirectly.

Hassler, Jasper O., and Rolland R. Smith, The Teaching of Secondary Mathematics. The Macmillan Company, New York, 1930. 405 pp.

This is an excellent reference book for mathematics teachers. Some of the methods suggested fit very nicely into visual aid programs although they are not so named.

Heiss, Elwood D., Ellsworth S. Obourn, and C. Wesley Hoffman, Modern Methods and Materials for Teaching Science. The Macmillan Company, New York, 1940. 351 pp.

This book contains excellent descriptive material on the visual aids and their use. It also has good directions for making lantern slides.

Hoban, Charles F., Focus on Learning. American Council on Education, Washington, D. C., 1942. 172 pp.

This is a report of the committee on motion pictures in education of the American Council on Education after five years of study.

_____, Charles F. Hoban, Jr., and Samuel B. Zisman, Visualizing the Curriculum. The Dryden Press, Inc., New York, 1937. 300 pp.
An excellent reference book on the types and uses of visual aids with a great deal of reference and illustrative material.

McKown, Harry C., and Alvin B. Roberts, Audio-Visual Aids and Instruction. McGraw-Hill Book Company, Inc., New York, 1940. 385 pp.
An excellent reference book on the types and uses of visual aids with a great deal of reference and illustrative material.

National Council of Teachers of Mathematics, The Mathematics Teacher, New York.
This is a monthly periodical of value to any teacher of mathematics. There is one section, "The Art of Teaching," which often has teaching suggestions that make use of visual aids.

Neblette, C. B., Frederick W. Brehm, and Everett L. Priest, Elementary Photography for Club and Home Use. The Macmillan Company, Boston, 1942. 289 pp.
This is an excellent guide book for the amateur photographer. Chapter XVI deals with making photographic lantern slides.

H. W. Wilson Company, New York. 1944 Educational Film Catalogue.
This book lists 2930 films for classroom use. They are classified as to subject and title with descriptive comments about each film.

Woodring, Maxie Nave, and Vera Sanford, Enriched Teaching of Mathematics in Junior and Senior High School. Bureau of Publications, Teachers College, Columbia University, New York, 1938. 129 pp.
This is a source book for free and inexpensive material to be used in the mathematics class. The writer found that some of the material was out of print or not available at present.

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